P5 TOWN-HALL FERMILAB/ARGONNE

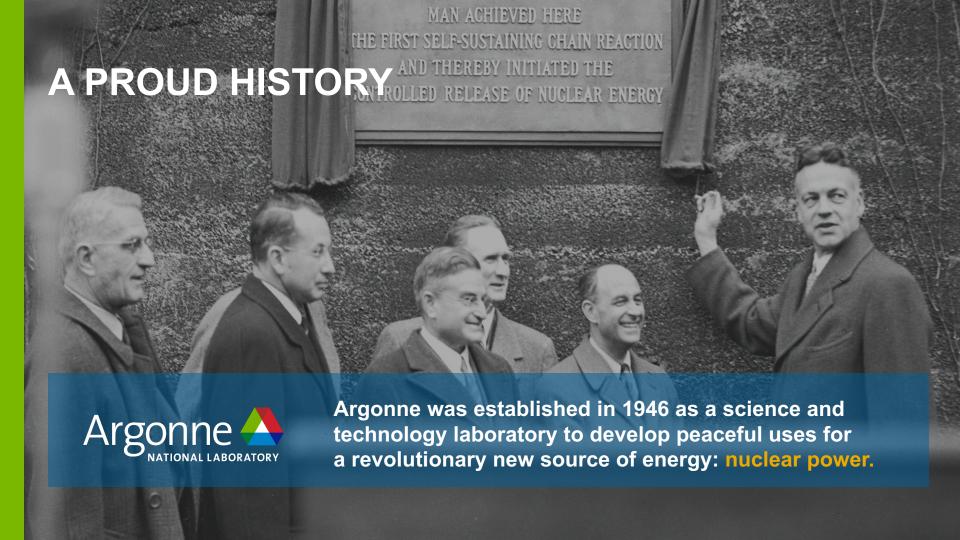


ARGONNE NATIONAL LABORATORY AND HIGH ENERGY PHYSICS



RIK YOSHIDA HEP DIVISION DIRECTOR ARGONNE NATIONAL LAB





DIVERSIFIED RESEARCH PORTFOLIO

\$1.1 Billion in FY2021

End to End

From discovery to application

User Facilities

Integrated with our research

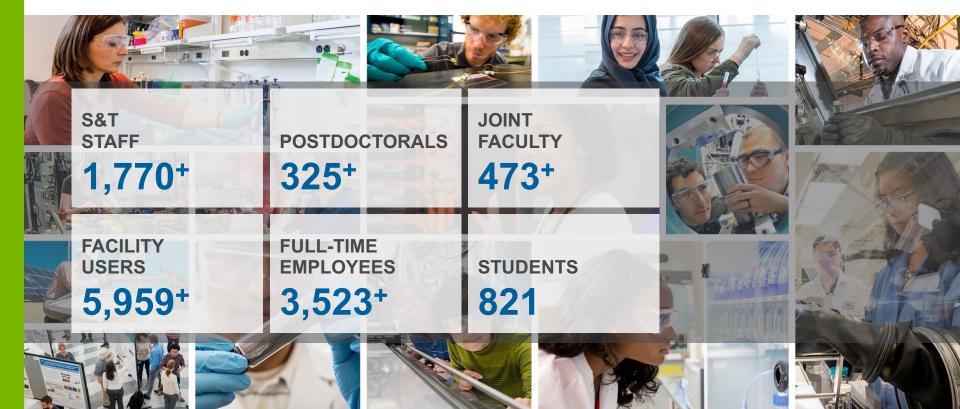
Collaborations

Within and outside of Argonne



FOSTERING A DIVERSE, WORLD-CLASS COMMUNITY OF TALENT

FY2021



ARGONNE'S RESEARCHERS AND DISCOVERIES ARE WIDELY RECOGNIZED



R&D 100

Awards



National and international awards and honors



Inventions recorded and patents issued



Numerous DOE commendations, including Secretary's Awards

Nobel Laureates



1938 Enrico Fermi



Maria Goeppert Mayer



2003 Alexei Abrikosov



ARGONNE AND ARGONNE HEP



Materials, Nanoscience

Leadership Computing

Nuclear Physics

Photon Science

AN ENVIRONMENT WITH MANY OPPORTUNITIES FOR SYNERGIES

"ARGONNE High Energy Physics division (HEPD) will carry out cutting edge research in Energy, Intensity and Cosmic Frontiers while becoming a hub of innovation in the utilization of the new developments in computing, detectors and accelerator technologies for HEP science". Argonne HEP Vision Document submitted to DOE-HEP March 2021 HEP Division ~100 members ~40 core staff

HEP DIVISION MAIN RESEARCH THRUSTS

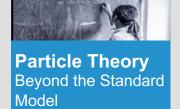


Muon Program g-2, mu2e Neutrino Program DUNE, microBooNE



Cosmic Frontier
Cosmic Theory and
Computing
CMB and Dark Energy
SPT, DESI
CMB-S4, LSST-DESC





Precision QCD





Cross-cutting

- Computing
- AI/ML
- QIS

Will not discuss the program detail but concentrate on unique synergies at Argonne

CONSIDERING MODES OF COLLABORATION

Several modes of cross-cutting Examples at Argonne

Aims of HEP and other Divisions align closely (integration)

- CPAC: Computational Cosmology
 HEP (Aim: Cosmology Science) CELS(Aim: Scientific HPC at Scale)
- AWA and the Argonne Accelerator Institute

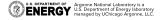
Extension of other Division's interests will serve HEP (funds)

 MSD-Superconductivity and Magnetism Group: collaborate for Superconducting Detectors.

Collaborating on Specific Research Topics (no funds from HEP)

- HEP Neutrino effort and PHY(NP) Theory group that produce Nuclear models.
- AWA and NP accelerator program collaborating on Al/ML of acc. controls.
- South Pole Renewable Energy

All modes of collaboration are put to use





EXAMPLE: COMPUTING SYNERGY

Capability: Cosmic Frontier at HEPD

- Cosmology Theory
 - Computational Cosmology

initial connection

Needs: Energy Frontier at HEPD

- HPC for LHC
- AIML for LHC

Similar for other areas

Needs: Particle Theory

Needs: Intensity Frontier

Needs: Accelerator

Take advantage of CF expertise

leading to







New connection

- HPC for LHC computing
- Center for Computational Excellence
- <u>Early Science Program</u> (Exascale)
- Exascale Computing Project (ECP) <u>Exasky</u>





HEP-CCE

Salman Habib (Argonne) Paolo Calafiura (LBNL)

Adam Lyon (Fermilab) Peter Nugent (LBNL) Kerstin Kleese van Dam (BNL)



Exascale Computing for HEP Experiments

- 3-year pilot project (FY20-23)
 - Develop practical solutions to port hundreds of kernels to multiple platforms
 - Collaborate with HPC communities on data-intensive use cases
 - Under evaluation for four-year extension.
- HEP-CCE focus areas
 - PPS (Portable Parallelization) Strategies)
 - IOS (IO and Storage)
 - EG (Optimizing Event Generators)
 - CW (Complex Workflows on HPC systèms)

Advanced Scientific Computing Research (ASCR) Research and Facilities

HEP-CCE

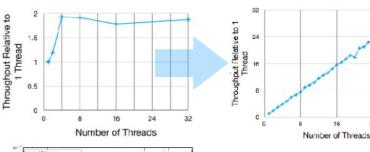
High Energy Physics (HEP) **Research and Facilities**

ASCR Programs

Argonne 🕰

₹ Fermilab

Computational HEP Program Cross-Cuts



computation of n-gluon matrix elements

Top: ROOT IO improvements

Left: Ported kernels from MadGraph using Kokkos to CPUs and GPUs, demonstrated GPU speedups

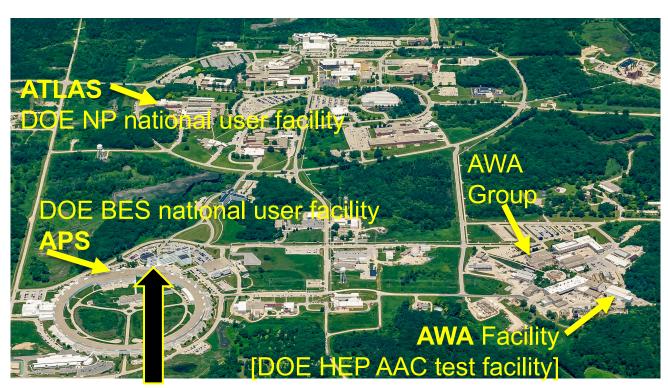
Salman Habib



https://www.anl.gov/hep-cce



EXAMPLE: ARGONNE ACCELERATOR INSTITUTE (AAI)



- 3 main accelerators at Argonne
- BES user facility (light source)
- NP user facility (heavy ions)
- HEP test facility

Basis for many synergies

AAI RECENT HIGHLIGHT (APS AND AWA)

Ultra high-gradient, X-band RF cathode gun.

Demonstrated 400 MV/m gradient (~factor 3-4 increase over state-of-the-art)

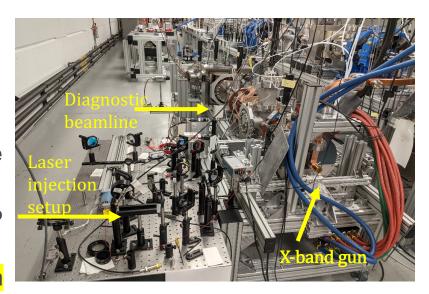
Improvement compared LCLS gun

Gradient 120 MV/m → 400 MV/m

Potential to decrease emittance

- For future HEP linear collider, reduce the site power (and op cost) by 30%.
- For FEL, raise photon energy by 50%
 - hv = 13 keV → 20 keV

at little to no additional cost in construction



John Power

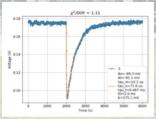


EXAMPLE: DETECTOR R&D

Superconducting Detectors



MKID fabricated at Argonne



Trace of a cosmic ray event in an Argonne low-Tc TES device



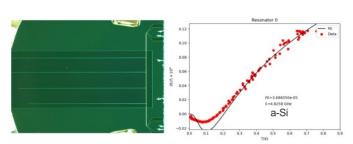
Strong collaborations with Material Science Division & Center for Nanoscale Materials (BES user facility)



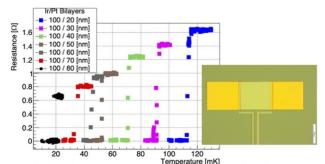


SUPERCONDUCTING DETECTOR DEVELOPMENT AT CNM/ACR

From basic materials research to full-scale detector arrays

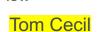


Low-loss dielectrics for microwave / mmwave circuitry



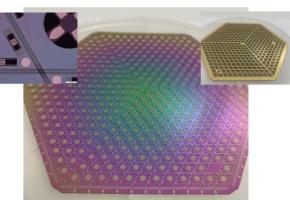
Ultra-low Tc superconductors for low-

(ENERGY





Superconducting spectrometer prototype



CMB-S4 array



Superconducting
Detector
development is
enabled by
collaboration with
MSD and CNM



EXAMPLE: WORKING WITH THE ENERGY SECTOR

ACCESS and Advanced Energy Technologies Directorate

Over a year ago we began to think about deploying renewable energy at the South Pole to enable CMB science. (Argonne is an energy lab!)

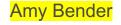


South Pole is a unique environment

- Dark half of the year
- Currently operates on diesel power with challenging logistics for refueling.

Environmental concerns but also could be a win on purely economic terms!







WORKING WITH THE ENERGY SECTOR

ACCESS and Advanced Energy Technologies Directorate

We were able to quickly establish a collaboration between:

- HEP: CMB science and South Pole local knowledge
- ACCESS: Stationary Energy Storage
- AET: Energy Systems and Infrastructure Analysis.

Strong support from PSE and Argonne Directorate.

Eventually, we teamed with NREL to establish a joint team—with the director's support



A paper on this study coming soon.

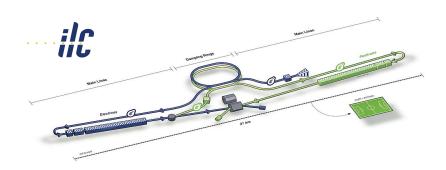


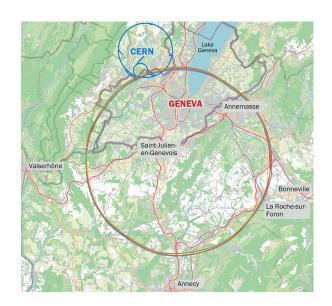


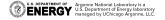
LARGER CONTEXT

Renewable Energy and Future (and present) HEP Projects

- HEP Facilities require large amounts of energy.
- This will be even more so for future HEP projects.









LARGER CONTEXT

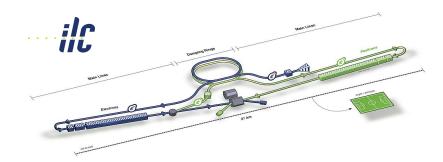
Renewable Energy and Future (and present) HEP Projects

Must consider alternative sources of energy at future projects.

National Laboratories, such as Argonne is a place where cutting-edge energy science can

be brought to bear.

We have made a first step with the SP RE Study.









COLLABORATING OUTSIDE HEP SCIENCE

Effective Collaboration with other fields are increasingly important

- Scientific and technology disciplines outside HEP have resources and expertise that cannot be matched by just working within HEP.
 - Material Science
 - Computing
 - Energy Sciences
 - **–** ...
- If we can find effective *collaboration* with other disciplines, HEP can benefit enormously.
- At Argonne HEP, we have been successfully explored these collaboration for a couple of decades.
- We believe there are many further areas of possible fruitful collaborations with other sciences and technologies, not only at Argonne and for wider HEP.
- Large multidisciplinary laboratory such as Argonne can play a big role in this.



